5 Computer Method

This chapter explains the use of approved public domain and *Alternative Calculation Method (ACM)* computer programs to show compliance with the annual energy budget requirement of the *Energy Efficiency Standards* (*Standards*). These *computer methods* provide a more flexible way to meet the *Standards* compared to the prescriptive packages explained in Chapter 3.

Computer method compliance works by calculating the energy use of the proposed design and comparing it to the allowable energy budget for the standard design. If the proposed design uses equal or less energy than the standard design, then the building complies. This method has the most flexibility because the building designer may trade-off the energy performance of different building components and design features to achieve compliance. The computer method is the most popular compliance method under the *Standards*. The introductory section outlines the basis of the computer method approach and the ACM approval process for the use of computer programs with the *Standards*. Following sections summarize the compliance procedure with computer methods.

Section 5.4 of this Chapter describes computer input values and proposed design modeling techniques. Guidelines for special modeling cases such as zonal controls, controlled ventilation crawl spaces and sunspaces are also contained in Section 5.4. Input descriptions relating to water heating calculations are contained in Chapter 6. Section 5.5 outlines standardized computer method compliance reports using printouts from an approved computer program. Section 5.6 describes how the standard design energy budget is determined.

In addition to the information contained in this Chapter, each approved computer program is required to have a compliance supplement that provides important information regarding the use of that program for showing compliance with the *Standards*.

5.1 Introduction

Computer methods are computer programs approved by the California Energy Commission as being capable of calculating space conditioning and water heating energy use in accordance with a detailed set of rules. The methods simulate or model the thermal behavior of buildings by calculating heat flows into and out of the various thermal zones of the building. Because of their relative accuracy in analyzing annual space conditioning and water heating energy use of different building conservation features, levels and techniques, computer methods are the basis of performance standards as established by the Warren-Alquist Act.

A computer method can perform a significant number of calculations to project the interactive thermal effects of many different building components in conjunction with specific outdoor weather conditions. The calculations include:

- Heat gain and heat loss through walls, roof/ceilings, floors, fenestration and doors
- Solar gain through fenestration as affected by orientation and exterior shading devices.

- Natural ventilation by operable windows and infiltration through cracks and porous surfaces in the building envelope
- Heat storage effects of different types of thermal mass in buildings with large amounts of mass (e.g., passive solar buildings)
- Efficiencies of mechanical heating and cooling equipment and duct systems

The prescriptive packages (Chapter 3) were derived by the Commission from the results of building energy analysis studies using the Commission's reference computer method.

Computer methods are generally the most detailed and flexible compliance path. The energy performance of a proposed building design can be calculated according to actual building geometry, site placement and building features like insulation levels, fenestration performance and equipment efficiencies. Credit for certain conservation features, such as ducts located in conditioned space and reduced building envelope leakage, cannot be taken in the prescriptive packages, but can be evaluated with an approved computer method.

Note: Compliance credit for certain features, such reduced building envelope air leakage, that require diagnostic testing and field verification also require special documentation and processing. See Section 4.3 for diagnostic testing and field verification requirements.

For a computer method to be used for compliance with the *Standards*, the method must first be approved by the Commission. Approval involves the demonstration of minimum modeling capabilities and program documentation. The program must be able to:

- Automatically calculate the **energy budget** based upon the **standard design** (see Section 5.2)
- Calculate the energy use of the proposed design in accordance with specific fixed and restricted inputs
- Perform basic water heating calculations (see Chapter 6)
- Print the appropriate standardized compliance reports (Section 5.5)

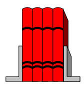
Modeling capabilities are tested by using the program to calculate the energy use of certain prototype buildings under specific conditions. The results are then compared with the results from the Commission's reference computer method.

The Commission approves the alternative calculation method according to the procedures outlined in Title 24, Part 1, § 10-101 through § 10-113. The procedures are detailed in the Residential Alternative Calculation Methods Approval Manual. Programs meeting this criteria are referred to as "ACMs" elsewhere in this Chapter.

The Commission periodically updates a listing of approved computer programs. This list may be obtained from the Commission's web site at www.energy.ca.gov/title24 , or Publications Office or by calling the Energy Hotline at (800) 772-3300, and is included in this *Manual* as Appendix F.

5.2 Compliance with a Computer Method

5.2.1 Combined Energy Budget



§ 151(b)

Performance Standards. A building complies with the performance standard if its combined calculated depletable energy use for water heating (§ 151(b)1) and space conditioning (§ 151(b)2) is less than or equal to the combined maximum allowable energy use for both water heating and space conditioning, even if the building fails to meet either the water heating or space conditioning budget alone.

1. Water heating budgets. The budgets for water heating systems are those calculated from Equation 6-2.
2. Space conditioning budgets. The space conditioning budgets for each climate zone shall be the calculated consumption of energy from depletable sources required for space conditioning in buildings in which the basic requirements of § 151(a) and the measures in alternative component package D are installed. To determine the space conditioning budget, use an approved calculation method.

5.2.2 Combined Energy Budget: Space Conditioning and Water Heating Energy Use

Each approved computer method automatically generates an energy budget by calculating the annual energy use of the standard design. The standard design is a building with the same size as the proposed design, but incorporating all conservation features of prescriptive Package D. There are two basic components to the energy budget: space conditioning and water heating. Space conditioning is further divided into space heating and space cooling.

A building complies with the *Standards* if the predicted source energy use of the proposed design is the same or less than the combined annual energy budget for space conditioning and water heating of the standard design. As explained in Chapter 6, the energy budget for water heating energy use varies for each dwelling unit depending on the total conditioned floor area. The budget for space heating and cooling varies according to specific characteristics of the proposed building design.

Since standard design is derived by assuming equal distribution of fenestration area on all four cardinal orientations, the energy budget remains the same regardless of how the actual building is oriented. Variables that affect the energy budget are:

- Conditioned floor area
- Conditioned volume
- Number of stories
- Number of dwelling units
- Gross roof/ceiling area
- Gross wall area
- Slab edge length
- Conditioned Slab-on-grade area
- Raised floor area over crawl space

- Raised floor area over open space
- Heating system type
- Cooling system type
- Space conditioning distribution system type and location
- Climate zone

All other building-related inputs such as area and type of fenestration products, ventilation, HVAC efficiencies and duct efficiencies are automatically fixed in the standard design building according to the Package D requirements and are not accessible for modification by program users.

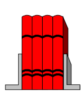
Figure 5-1 – Example Energy Use Summary on C-2R (Page 1)

Energy Summary (kBtu/ft^2-yr)		
	Standard Design Energy Budget	Proposed Design Energy Use
Space Heating	12.34	12.63
Space Cooling	8.97	7.12
Water Heating	11.76	11.76
Total	33.07	31.51

The energy budget and energy use for a building is summarized in an Energy Summary on the Computer Method Summary (C-2R) form illustrated in Section 5.5 and Figure 5-1. The Standard Design Energy Budget is calculated according to the rules and assumptions explained in Section 5.6, and represents the total allowable energy budget for the building.

The Proposed Design Energy Use must be equal to or less than that of the Standard Design Energy Budget for the building to comply.

5.2.3 Compliance Demonstration



§151(c)

Compliance Demonstration Requirements for Performance Standards. The application for a building permit shall include documentation that demonstrates, using an approved calculation method, that the new building has been designed so that its energy use from depletable energy sources does not exceed the combined water heating and space conditioning energy budgets for the appropriate climate zone.

Although any one or two components of the energy use may be higher than the same component in the energy budget (e.g., 12.63 kBtu/ft^2-yr versus 12.34 kBtu/ft^2-yr space heating), the combined energy use of the Proposed Design must be less than or equal to the combined energy budget of the Standard Design (e.g., 31.51 versus 33.07 kBtu/ft^2-yr). In this way, trade-offs can be made among water heating, space heating and space cooling energy use (see §151(b) of the *Standards*).

5.2.4 Additions

An approved computer method may be used to show compliance of an addition alone, or to show compliance of an addition accounting for the energy performance of the existing building. These approaches are explained in Sections 7.3 and 0.

5.3 General Compliance Procedure

Any approved computer method may be used to comply with the *Standards*. The following steps are a general outline of the typical computer method procedure:

1. Collect all necessary data—areas of fenestration products, walls, doors, roofs, ceilings and floors, construction assemblies, solar heat gain coefficients, equipment efficiencies, water heating information—from drawings and specifications. Although most computer methods require the same basic data, some information and the manner in which it is organized may vary according to the particular program used. Refer to the compliance supplement for the program being used for additional details.

2. If appropriate default U-factors for wall, roof/ceiling and floor are used (see Section 5.4, item B4), no Form 3Rs are submitted. If default values are not used, prepare the appropriate Forms 3R for the various proposed construction assemblies either through the use of the program or by hand calculation (see R-Value in the Glossary).

3. Prepare an input file describing the other thermal aspects of the proposed design according to the rules described in Section 5.4 and in the program's compliance supplement. Input values and assumptions must correctly correspond to the proposed design and conform to the required mandatory measures described in Chapter 2.

4. Generate a computer run to automatically calculate the Standard Design Energy Budget and the Proposed Design Energy Use.

   a. If the water heating system is a "standard system" as explained in Chapter 6, the water heating energy use is assumed to be the same for both the standard and proposed designs.

   b. If any other water heating system is to be used or if credit is being taken for a more conserving aspect of the water heating system, water heating energy use is calculated by the approved program as explained in Chapter 6. The computer printout must show the details of the water heating system that was modeled.

The building complies if the total energy use of the proposed design is the same or less than the standard design energy budget.

Professional Judgment. As explained in the next section, some modeling techniques and compliance assumptions applied to the proposed design are fixed or restricted. There is little or no freedom to choose input values for compliance modeling purposes. However, other aspects of computer modeling remain for which some professional judgment is necessary. In those instances, exercise proper judgment in evaluating whether a given assumption is appropriate.

Building departments have full discretion to reject a particular input, especially if the user has not substantiated the value with supporting documentation.

Two questions may be asked in order to resolve whether professional judgment has been applied correctly in any particular case:

- Is a simplifying assumption appropriate for a specific case? If simplification reduces the predicted energy use of the proposed building when compared to a more explicit and detailed modeling assumption, the simplification is not acceptable (i.e., the simplification must reflect higher energy use than a more detailed modeling assumption).

- Is the approach or assumption used in modeling the proposed design consistent with the approach or assumption used in generating the energy budget?

One must always model the proposed design using the same assumption and/or technique used by the program in calculating the energy budget unless drawings and specifications indicate specific differences that warrant conservation credits or penalties.

Any unusual modeling approach, assumption or input value should be documented with published data and should conform to standard engineering practice.

For assistance in evaluating the appropriateness of particular input assumptions, call the Energy Hotline (see Section 1.6) or call the vendor of the computer program (see Appendix F).

Note: When creating a computer input file, use the space provided for the project title information to concisely and uniquely describe the building being modeled. User-designated names should be clear and internally consistent with other orientations and/or buildings being analyzed. Title names and explanatory comments should assist individuals involved in both the compliance and enforcement process.

5.4 Proposed Design Modeling Procedure

This section summarizes the modeling and output information used in demonstrating compliance with approved computer methods. Program users and those checking for enforcement should consult the most current version of the user's manuals and associated compliance supplements for specific instructions on the operation of the program.

Input data entered into each approved computer method may be organized differently from one to the next. As a result, it is not possible in this summary to present all variables in their correct order or hierarchy for any one program. The aim is to identify a generic type of input variable and explain how it should be treated in the context of properly modeling the proposed building design for compliance. Descriptions of particular values are cross-referenced to key outputs shown on the sample Computer Method Summary (C-2R) forms in Section 5.5. Modeling assumptions used by the computer methods to calculate the standard energy budget are outlined in Section 5.6.

The following general reference categories may be used to find specific input/output descriptions that are grouped accordingly:

Table 5-1 – General Reference Categories for Input/Output Descriptions

MINIMUM CAPABILITIES	OPTIONAL CAPABILITIES
A. Building Information	N. Controlled Ventilation Crawl Space (CVC)
B. Walls, Doors, Roofs/Ceilings and Floors	O. Zonal Control
C. Fenestration	P. Attached Sunspaces
D. Shading Devices and Overhangs	Q. Combined Hydronic Space/Water Heating
E. Thermal Mass	R. Exterior Mass Walls
F. Natural Ventilation	S. Solar Water Heating
G. Mechanical Ventilation	T. Side Fin Shading
H. Infiltration Gains and Losses and Reduced Building Envelope Air Leakage	U. Gas-Fired Heat Pumps
I. Internal Gain & Thermostat Setpoints	V. Form 3 Report Generator
J. Space Conditioning System Efficiency and Distribution (Duct) System Efficiency	
K. Water Heating Efficiency and Distribution System	
L. Radiant Barrier and Cool Roofs	
M. Building Additions Modeled with or without Existing Buildings	

5.4.1 Building Information

Project Title Information A1

The project title should be used to clearly identify and distinguish one project, building, unit plan and/or orientation from another. Include as much title description as is useful.

Number of Dwelling Units A2

The number of dwelling units determines the value used for internal heat gain and the water heating energy budget in multi-family buildings.

When modeling an addition alone, the dwelling unit number is the fraction obtained by dividing the square foot area of the addition by the square foot area of the existing building plus addition.

Number of Stories A3

The number of habitable stories in the proposed design. A habitable story is defined as a story that contains space in which humans may work or live in reasonable comfort, and that has at least 50% of its volume above grade.

In the case of a second story addition modeled alone, the number of habitable stories in the proposed design should be input as "2". Single-family dwelling units with more than 3 stories may use an input of 3 stories.

Building Type A4

Building types are: Single Family (includes duplexes and halfplexes), Multi-Family (includes all other attached dwellings including condominiums), Addition, Existing-Plus-Addition or Alteration. The building type identifies for the computer programs which of the different modeling algorithms for internal heat gain and infiltration are used for the calculation of a particular energy budget.

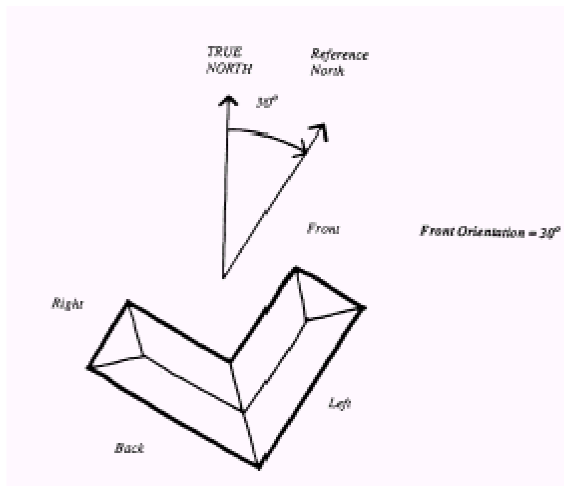
Front Orientation A5

This is a value that represents the rotation of the reference "Front" side or reference "Front" elevation of the building with respect to true north, expressed in degrees (see Figure 5-2). When compliance is demonstrated for all orientations, the reference orientation can be reported as North.

TRUE NORTH =	0	= True North
	90	= True East
	180	= True South
	270	= True West

Note: The "front" or "entry" door of the building may not necessarily be located in the wall designated in the drawings as the "Front" elevation. Any side of the building may be identified as the front as long as the output accurately reflects the orientation of opaque and fenestration surfaces.

Figure 5-2 – Determining Front Orientation



Total Conditioned Floor Area A6

Total conditioned floor area of the building, in square feet. See the Glossary for a full definition.

Conditioned Slab Floor Area

The conditioned slab area is the area of slab floor with conditioned space above and the ground (slab-on-grade) or unconditioned space below (raised slab). This input and the Total Conditioned Floor Area are used to determine the thermal mass modeled in the Proposed Design and the Standard Design.

Volume A7

Volume of all conditioned space, in cubic feet. This value is the product of total conditioned floor area and area-weighted average ceiling height.

Climate Zone A8

The specified climate zone allows the program to use the fixed weather data established by the Commission. Depending on the program, the city specified may automatically call the correct climate zone. Consult Appendix D or the program compliance supplement.

5.4.2 Walls, Doors, Roofs/Ceilings & Floors

Exterior Walls, Doors, Roofs/Ceilings and Raised Floors B1

Exterior surfaces are defined as surfaces that separate conditioned space from outdoor conditions or unconditioned spaces. See Unconditioned Space, Controlled Ventilation Crawl Space and the program compliance supplement for further information.

Each exterior surface has associated with it a user-defined name (which may not appear on compliance output), area, U-factor, orientation, tilt and absorptivity as described below.

The mass effect of exterior masonry walls may be modeled by computer methods with that optional capability. In those cases, exterior wall inputs include thermal mass attributes described in Subpart 5.4.5 and in the program compliance supplement.

Straw bales that are 23 inches by 16 inches are assumed to have a thermal resistance of R-30. (Performance data on other sizes of bales was not available at the time of publication of this *Manual*.) The minimum density of load bearing walls is 7.0 pounds per cubic foot, or the actual density. Specific heat is set to 0.32 Btu/lb/°F. Volumetric heat capacity is calculated as density times specific heat (at 7 lb/ft^3 the volumetric heat capacity is 2.24 Btu/ft^3/°F).

Name B2

A user-defined name should be used to clearly distinguish one wall or ceiling from another. When a building is to be run for compliance in all four orientations, "front" and "rear" designations are recommended instead of "north" and "south" (see Front and Back in the Glossary).

Note: user-defined names may be used and appear on input screens but the ACM must generate names such as WALL01 for compliance output.

Area B3

Net area of the exterior wall, basement wall/floor, roof/ceiling or raised floor, in square feet. The net area does not include the area of fenestration products and doors which are treated separately.

Some programs may allow the user to enter gross exterior wall area and automatically subtract the area of fenestration and doors. Consult the program compliance supplement.

Exterior wall area is measured from the lowest finished habitable floor to the ceiling of the uppermost floor.

Basement walls include below grade walls at depths of 2 feet, 2 to 6 feet, and greater than 6 feet. Above grade walls are modeled as conventional walls.

Floor and ceiling areas include the thickness of exterior walls. Vaulted roof/ceiling areas must be calculated for the surfaces through which heat loss occurs (e.g., insulation in a flat ceiling area or in a sloped roof area). Unless gross areas are used, skylight area is subtracted when computing net roof/ceiling areas.

U-factor B4

The U-factor of the construction assembly, in Btu/(ft^2-hr-°F) (see the Glossary). Standard U-factors shown in Table 5-2 may be used instead of completing and submitting a Form 3R. If a Form 3R is calculated (see R-Value in the Glossary), the "Total U-factor" from the bottom of the form is used in the calculations.

Ceiling U-factors are reduced by the ACM if an approved radiant barrier is installed.. See Subpart 5.4.14 for details.

Note: In the case where metal framing is used the overall U- factor of the assembly cannot be determined by using the Form 3R. To properly account for the high thermal conductivity of metal, the tables and methodology included in the Appendices for metal framing must be used to calculate a correct value.

Orientation B5

This is an input value representing the orientation of the exterior surface with respect to the reference "front" elevation, or relative to the front.

The "left" elevation is 90°, the "rear" elevation is 180°, the "right" elevation is 270°, and the "front" elevation is 0°. Surfaces at angles are calculated relative to the front elevation (0°).

Note: The C-2R printout shows actual orientation of each opaque and fenestration surface based on the rotation specified building front orientation

Tilt B6

The tilt of the exterior surface is defined to be 0° for a horizontal (face up) roof/ceiling, 90° for a vertical wall and 180° for a floor (face down).

Solar Gains B7

Solar gains is either "Yes" for all exterior surfaces exposed to any direct sunlight or "No" for surfaces that do not receive direct solar gain (e.g., a wall separating conditioned space and a garage).

Table 5-2A – Standard U-factors of Wood Frame Roofs/Ceilings and Walls[1]

Roof/Ceiling Insulation	*Framing Spacing*	*Reference*[2] *Name*	*U-factor*
R-0[3]	16" o.c.	R.0.2X6.16	0.297
R-0[3]	24" o.c.	R.0.2X4.24	0.305
R-11[3]	16" o.c.	R.11.2X6.16	0.076
R-11[3]	24" o.c.	R.11.2X4.24	0.076
R-13[3]	16" o.c.	R.13.2X6.16	0.069
R-13[3]	24" o.c.	R.13.2X4.24	0.068
R-19	16" o.c.	R.19.2X8.16	0.051
R-19	24" o.c.	R.19.2X4.24	0.047
R-22	16" o.c.	R.22.2X10.16	0.044
R-22	24" o.c.	R.22.2X4.24	0.041
R-30	16" o.c.	R.30.2X10.16	0.036
R-30	16" o.c.	R.30.2X12.16	0.035
R-30	24" o.c.	R.30.2X4.24	0.031
R-38	16" o.c.	R.38.2X12.16	0.030
R-38	16" o.c.	R.38.2X14.16	0.028
R-38	24" o.c.	R.38.2X4.24	0.025
R-49	16" o.c.	R.49.2X4.16	0.019
R-49	24" o.c.	R.49.2X4.24	0.019
Wall Insulation			
R-0[3]	16" o.c.	W.0.2X4.16	0.385
R-0[3]	24" o.c.	W.0.2X4.24	0.392
R-7[3]	16" o.c.	W.7.2X4.16	0.130
R-7[3]	24" o.c.	W.7.2X4.24	0.127
R-11[3]	16" o.c.	W.11.2X4.16	0.098
R-11[3]	24" o.c.	W.11.2X4.24	0.094
R-13	16" o.c.	W.13.2X4.16	0.088
R-13	24" o.c.	W.13.2X4.24	0.084
R-15	16" o.c.	W.15.2X4.16	0.081
R-15	24" o.c.	W.15.2X4.24	0.077
R-19	16" o.c.	W.19.2X6.16	0.065
R-19	24" o.c.	W.19.2X6.24	0.063
R-21	16" o.c.	W.21.2X6.16	0.059
R-21	24" o.c.	W.21.2X6.24	0.056
R-25	16" o.c.	W.25.2X6.16	0.046
R-29	16" o.c.	W.29.2X4.16	0.035
R-30	No Framing[4]	Straw	0.033
Solid core wood door (no insulation)		D.0.SCW	0.330

1. Based on ASHRAE Parallel Heat Flow Calculation, ASHRAE Handbook of Fundamentals.
2. These Reference Names are taken from Appendix H. Roof/ceiling assemblies listed with 2x4 framing include an attic space.
3. Does not meet the minimum level required as a mandatory measure (see Section 2.2).
4. Framing that penetrates no more than 25% of the way through the strawbale.

Table 5-2B – Standard U-factors of Wood Frame Raised Floors[1]

Floor Insulation	Condition	Reference[2] Name	U-factor
R-0[3]	No crawl space	FX.0.2X6.16	0.238
R-0[3]	Crawl space	FC.0.2X6.16	0.097
R-11[3]	No crawl space	FX.11.2X6.16	0.071
R-11[3]	Crawl space	FC.11.2X6.16	0.049
R-13	No crawl space	FX.13.2X6.16	0.064
R-13	Crawl space	FC.13.2X6.16	0.046
R-19	No crawl space	FX.19.2X8.16	0.048
R-19	Crawl space	FC.19.2X8.16	0.037
R-21	No crawl space	FX.21.2X8.16	0.045
R-21	Crawl space	FC.21.2X8.16	0.035
R-30	No crawl space	FX.30.2X10.16	0.034
R-30	Crawl space	FC.30.2X10.16	0.028

1. Based on ASHRAE Parallel Heat Flow Calculation, ASHRAE Handbook of Fundamentals.
2. The Names given to the standard assemblies used to calculate these U-factors in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Section 2.2).

Table 5-2C – Standard U-factors of Wood Foam Panel Roofs/Ceilings and Walls[1]

Roof/Ceiling	Framing	Reference[2]	
Insulation	Spacing	Name	U
Value			
R-14[3]	48" o.c.	RP.14.2X4.48	0.064
R-22	48" o.c.	RP.22.2X6.48	0.044
R-28	48" o.c.	RP.28.2X8.48	0.035
R-36	48" o.c.	RP.35.2X10.48	0.029
Wall Insulation			
R-14	48" o.c.	WP.14.2X4.48	0.071
R-22	48" o.c.	WP.22.2X6.48	0.049

1. Based on ASHRAE Parallel Heat Flow Calculation, ASHRAE Handbook of Fundamentals.
2. The names given to the standard assemblies used to calculate these U-factors in Appendix H.
3. Does not meet the minimum level required as a mandatory measure (see Section 2.2).

Slab-On-Grade B8

Slab floors coupled directly to the ground (i.e., poured directly on grade) fall into this category. Post-tensioned slabs suspended over a garage, for example, are treated as exterior (raised) floors but are included as part of the Conditioned Slab Floor Area.

Thermal mass characteristics of slab floors are explained in Section 5.4.5.

Slab Area B9

The gross area of slab-on-grade, in square feet. This value is needed for the program to calculate the net area of covered slab and the conditioned footprint area of the building.

Slab Edge Length B10

The length of slab edge through which there is heat loss, in feet. The slab edge length is fixed to assume 80% is carpeted or covered and 20% is exposed to conditioned air in ACM calculations.

Slab heat transfer is modeled through the slab edge. The heat flow is a function of the surface treatment of the slab, and the R-value and depth of any edge insulation (B11).

Slab Edge F2 Factor B11

Slab Edge Insulation Depth and R-Value or F2 Factor. The F2 factor defines the slab loss per linear foot of slab edge. Depending on the program, the user specifies the F2 factor directly or may specify the insulation depth and R-value and allow the program to calculate the F2 factor.

Any portion of a slab edge located between conditioned space and an attached and enclosed conditioned space (e.g., a garage or crawl space) may be modeled as if R-7 insulation is installed to a depth of 16". In climate zones 1 and 16 only, slab edges adjacent to an entry slab may also be calculated as if R-7 insulation is installed to a depth of 16". The perimeter length of bermed (under ground) walls is modeled as slab edge.

Note: In a building with a hydronic radiant slab floor heating system (see Section 8.8), the required slab edge insulation depends on climate and the location of the insulation. However, the slab must be modeled without credit for slab edge insulation.

Table 5-2D – Standard U-factors of Steel Frame Walls[1]

Wall Insulation	Insulation Sheathing R-Value	Framing Type	Framing Spacing	U-factor[2,3]
R-11[3]	0	2x4	16" o.c.	0.202
R-11	7	2x4	16" o.c.	0.084
R-11[3]	0	2x4	24" o.c.	0.173
R-11	7	2x4	24" o.c.	0.078
R-13[3]	0	2x4	16" o.c.	0.195
R-13	7	2x4	16" o.c.	0.082
R-13[3]	0	2x4	24" o.c.	0.165
R-13	7	2x4	24" o.c.	0.077
R-15[3]	0	2x4	16" o.c.	0.189
R-15	7	2x4	16" o.c.	0.077
R-15[3]	0	2x4	24" o.c.	0.158
R-15	5	2x4	24" o.c.	0.088
R-19[3]	0	2x6	16" o.c.	0.162
R-19	7	2x6	16" o.c.	0.075
R-19[3]	0	2x6	24" o.c.	0.135
R-19	4	2x6	24" o.c.	0.088
R-21[3]	0	2x6	16" o.c.	0.157
R-21	5	2x6	16" o.c.	0.088
R-21[3]	0	2x6	24" o.c.	0.130
R-21	4	2x6	24" o.c.	0.086
R-22[3]	0	2x6	16" o.c.	0.158
R-22	5	2x6	16" o.c.	0.088
R-22[3]	0	2x6	24" o.c.	0.132
R-22	4	2x6	24" o.c.	0.086

1. Based on ASHRAE Heat Flow Calculation, ASHRAE Handbook of Fundamentals.
2. The U-factor must be no greater than 0.088 to comply. See also Appendix I, Table I-1.
3. Does not meet the minimum level required as a mandatory measure (see Section2.2).

5.4.3 Fenestration

Fenestration C1

Fenestration products include all windows, skylights and exterior doors with glazing (see Section 2.3 and the Glossary.) All fenestration must be modeled if it separates conditioned space from the outside or from unconditioned space. In some special cases, fenestration is not modeled as exterior surface (e.g., in the case of an unheated sunspace) as explained in the program compliance supplement. See Unconditioned Space later in this section and the program compliance supplements.

Fenestration Name C2

The user-defined name should be used to indicate the type of fenestration product and associated shading.

When a building is to be run in all four orientations, "front" and "back" designations should be used instead of "north" and "south" (see Front in the Glossary).

Area C3

The sash or frame opening area of the fenestration product, in square feet (see Glossary). The area calculated from the nominal or rough opening dimensions is generally acceptable. The full area of French doors must be included, as well as the rough opening of greenhouse/garden windows.

A greenhouse/garden window is a window that projects from the building but does not extend to the ground and is not intended for use as a habitable space (e.g., used for shelves).

U-factor C4

The rated U-factor of the fenestration product, in Btu/hr-ft^2-°F. This is the U-factor that the manufacturers display as a label on all windows and skylights. Section 2.3 for a discussion of window, glass door and skylight ratings.

Orientation C6

The orientation of the glazing surface with respect to the "front orientation" (see Figure 5-2).

The "left" elevation is 90°, "back" elevation is 180°, right elevation is 270°, and "front" elevation is 0° for a typical building. See A5, Front Orientation, and B6, Wall Orientation, in this section.

Note: The C-2R printout shows actual orientation of each opaque and glazing surface is based on the specified Front Orientation.

Tilt C7

The tilt of the fenestration is defined to be 0° for a horizontal skylight and 90° for a vertical window or clerestory. The actual tilt of the fenestration should be entered (e.g., 18° for a skylight in a 4:12 roof pitch).

Operable Window Type C8

Acceptable opening types are Slider, Hinged (casement, French door, awning or hopper), or Fixed (picture window). The default for windows is Slider. To determine the standard design, the assumption is that all fenestration openings are operable slider type. Some ACM's do not provide this input and use the default Slider instead. Consult compliance supplement for further information.

The area of operable fenestration is important in the natural ventilation effectiveness calculated by the program.

When credit for hinged operable fenestration is taken, all fixed fenestration areas must also be accounted for as part of the calculation of total vent area:

Equation 5-1

$$Vent_{area} = (Area_{slider} \times 0.1) + (Area_{hinged} \times 0.2) + (Area_{fixed} \times 0.0)$$

When the area of hinged windows are entered, the area of sliders must also be entered and the area of fixed windows must equal the difference between the total fenestration area and the sum of the areas of the sliders and hinged fenestration or a program error will result.

Free vent area is divided up into 50% of the total free vent area as inlet area and 50% of the free vent area as outlet area. Although this calculation is done automatically within the program, the equation is needed to area-weight height differences between inlet and outlet vents as explained in F7.

5.4.4 Shading

Shading Characteristics D1

Shading can be defined as a fixed overhang and/or side fins relating to a particular glass area; as a fixed exterior screen or shade with a specified solar heat gain coefficient; or as a window with shading properties (e.g. low solar gain glass). For a full explanation of Shading, see the Glossary and consult the program compliance supplement.

SHGC Fenestration D2 The SHGC for the fenestration product, which includes the shading effects of framing and dividers, is obtained from manufacturer's literature, product label, or from Table G-8 (see Solar Heat Gain Coefficient in the Glossary).

Interior Shade D3 Interior shading is not a compliance variable. Approved ACMs are required to model a standard drape for windows and no drape for skylights. The standard drape is a modeling assumption and is not required to be installed or present at final inspection

Exterior Shade D4 Credit for exterior devices is determined from the description of the exterior shading device:

Table 5-3 – Descriptors for Exterior Shading Devices

Descriptor	Exterior Shading Device
Standard	Bug Screen
WvnScrn	Woven SunScreen
LvrScrn	Louvered SunScreen
LSASnScrn	Low Sun Angle (LSA) Sunscreen
RlDwnAwng	Roll-down Awning
RlDwnBlnds	Roll -down Blinds or Slats
None	None (Skylights Only)

Note that "None" is only allowed for skylights and is the default exterior shade for skylights.

Height of Shaded Fenestration D5 Height of fenestration to be shaded, in feet.

In most programs, fenestration height is used only to establish the geometry of the shading condition for overhangs and fins, not to compute fenestration area (which is entered elsewhere.)

For a particular overhang, the area-weighted average height may be used if combining different windows is judged appropriate according to Section 5.2 of this chapter.

Width of Shaded Fenestration D6 Width of fenestration to be shaded, in feet.

Fenestration width is used generally to establish the geometry of the shading condition for overhangs and fins, not to compute fenestration area (which is input elsewhere).

An average fenestration width may be used if combining different windows is judged appropriate according to Section 5.2 of this chapter.

Overhangs D7 Dimensions which describe an overhang above the fenestration, in feet: Depth of the overhang, vertical distance from the top of the fenestration to the overhang, extension of the overhang at the sides, height of the overhang flap (depending on the program). Consult the program compliance supplement for further information.

Fins D8 Dimensions which describe side fins to the left and/or right of the fenestration, in feet: Depth of fins, extension of fins above the fenestration, distance from the fins to the fenestration and the extension of fenestration below the fins (depending upon the program). Consult the program compliance supplement for further information.

Substantially Shaded Fenestration D9 Substantially shaded fenestration may be modeled with an exterior solar heat gain coefficient of 0.20. For more details on the requirements that must be met, refer to Solar Heat Gain Coefficient in the Glossary.

5.4.5 Thermal Mass

Thermal mass credit is restricted to buildings designed to take advantage of thermal mass such as passive solar designs. For typical buildings there is no credit because thermal mass is modeled the same for both the Proposed Design and the Standard Design. Thermal mass receives credit only when the amount of mass in the Proposed Design exceeds a high mass threshold equivalent to 30% exposed slab-on-grade. Refer to the program compliance supplement to learn more about specific thermal mass modeling techniques and optional capabilities.

Mass Material Name E1 — A user-defined name for a thermal mass material not already included as part of the program's materials library.

Surface Area E2 — Surface area of the thermal mass, in square feet. If both surfaces of an interior mass wall are exposed to conditioned space, use half the thickness of the wall and the total area of both wall surfaces. Both surfaces are coupled to zones called "House" (see E7).

The surface area of covered slab-on-grade is the calculated exposed slab area subtracted from the total gross slab area. Unless the amount of exposed slab-on-grade area exceeds the mass threshold, there will be no difference in the compliance results when the entire slab area is modeled as a covered slab.

Thickness E3 — Thickness of the thermal mass, in inches. If both surfaces of a solid interior mass wall such as grouted concrete block are directly exposed to conditioned air, the full thickness of the wall should be assigned to the mass element which is then coupled to two "House" zones as explained in E2 and E7.

Volumetric Heat Capacity E4 — Heat capacity of one cubic foot of the material, in Btu/ft^{3}°F. Consult the compliance supplement for the specific program being used to select the appropriate value for a generic mass material listed in Table G-12.

Conductivity E5 — Thermal conductivity of the mass material, in Btu/hr-ft^{2}-°F. Consult the compliance supplement for the specific program being used to select the appropriate value for a generic mass material.

Surface Resistance E6 — Heat transfer at the surface of the mass is expressed as thermal resistance, in (hr-ft^{2}-°F)/Btu.

This value is used to account for a treatment such as carpet which, like any "covered" surface, is assumed to have a surface resistance of R-2.0. In modeling a slab-on-grade building, all mass area that is not exposed is assumed to be covered.

Mass Coupling E7 — The coupling of the thermal mass defines the building zone (e.g., "house") or temperature condition to which the mass surface is connected. Each side of the mass is coupled either to a conditioned space, an unconditioned space or the ambient (outdoor) conditions.

Thermal mass is considered "interior" if all of its surface area, such as both sides of a masonry partition are exposed to the conditioned space. Thermal mass coupled to conditioned space on one side and exposed to outdoor conditions on the other side is "exterior" mass. The CF-1R and C-2R forms (see Section 5.5 and Appendix A) make clear which type of mass is included in the proposed design.

5.4.6 Infiltration/Ventilation and Reduced Building Envelope Air Leakage

Approved computer programs use a default building envelope air leakage (expressed in terms of Specific Leakage Area, SLA) for proposed designs when the user does not intend to take compliance credit for building envelope sealing. The default is set at 4.9 SLA except for dwellings using non-ducted HVAC systems where the default SLA is 3.8 for both the Proposed and Standard Designs. Careful attention to building envelope sealing would result in significantly lower SLA levels which may be modeled subject to verification by a HERS rater.

Reduced Building Envelope Air Leakage through Diagnostic Testing F1

Compliance credit can be taken for reduced building envelope leakage verified through diagnostic blowerdoor testing as described in Chapter 4.

There are special mechanical ventilation requirements when the building is designed for low building envelope leakage and mechanical **supply** ventilation requirements when diagnostic testing indicates that the building is "unusually tight." These are described in Chapter 4.

Mechanical Ventilation Wattage of Ventilation Supply and Exhaust Fans F2

The total power consumption of the continuous supply ventilation fans and continuous exhaust fans are input when compliance credit is taken for reduced building envelope leakage and mechanical ventilation is installed.

Ventilation Supply and Exhaust Fans F3

The volumetric capacity of continuous supply fans and continuous exhaust fans are input when continuous mechanical ventilation is installed.

Reduced Duct Leakage F4

If compliance credit is **not** taken for reduced building envelope air leakage through diagnostic testing, a special "default" compliance credit can be taken for building envelope leakage reduction resulting from reduced duct leakage. To qualify for this credit all requirements of Section 4.1.7 must be met. Compliance credit is provided for a "default" reduction in Specific Leakage Area of 0.50.

Air Retarding Wrap F5

If compliance credit is **not** taken for reduced building envelope air leakage through diagnostic testing, a special "default" compliance credit can be taken for building envelope leakage reduction resulting from installation of an air retarding wrap (i.e., housewrap). There are special qualifications for the use of these wraps to get credit which are described in Chapter 4.

When compliance credit is taken for an air-retarding wrap, the computer program must automatically include the air retarding wrap and the required specifications in the Special Features and Modeling Assumptions section of the CF-1R and C-2R to facilitate inspection by the local enforcement agency. Compliance credit for an air retarding wrap does not require HERS rater verification.

Compliance credit is provided for a "default" reduction in Specific Leakage Area of 0.50.

Natural Ventilation for Cooling F6

Approved compliance programs assume that windows are opened for natural ventilation when outside temperatures are conducive for providing outside cooling. For buildings with typical thermal mass levels, default assumptions for natural ventilation are used. For high mass buildings, compliance credit can be taken for increased free ventilation window area and increased ventilation height.

Ventilation Height Difference F7

A height difference of 2 feet is input for one-story dwelling units (even if the dwelling unit occurs in a two or three-story building). A value of 8 feet is input for two and three-story dwelling units.

A different value for the height difference between horizontal center lines of inlet and outlet openings corresponding to the actual building design is acceptable if properly documented. An area-weighted calculation is required to document credit for any value larger than the standard value.

5.4.7 Internal Gain & Thermostat Setpoints

Internal Heat Gain G1

Total internal heat gain per day from occupants, lights, appliances and other heat-generating equipment is automatically fixed by the program according to the number of dwelling units in the building and the total conditioned floor area. The hourly schedule of internal gain is also fixed.

In modeling additions, the internal heat gain associated with the addition as a separate compliance entity is also calculated by the program on a prorated basis as compared with the existing-plus-addition (see Section 7.3.3).

Internal gain related to modeling a zonally-controlled space is also automatically fixed by the program. The living zone and sleeping zone are assigned various portions of the internal gain according to specific rules (see M1, Zonal Control in this section).

Thermostat Setpoints G2

Thermostat setpoints for heating, cooling and venting are fixed by the program based on setback or no setback. Settings are inaccessible by the program user. Special thermostat settings for the zonal control model are also built in and automatically used when zonal control is specified in computer methods approved with that approach (see M1, Zonal Control in this section).

Certain types of heating and cooling equipment are exempt from the setback thermostat mandatory measure (see Section 2.5.3). When no setback thermostat is installed, the computer method must assume a 66°F night setback heating setpoint.

The program also allows the specification of unconditioned zones with thermostats set to insure that no heating or cooling occurs in those areas (see Section 5.4.11, Unconditioned Space).

5.4.8 Space Conditioning System

Heating System Type H1

Heating system types include gas, heat pump and electric resistance. Gas refers to any non-electric fuel such as natural gas, oil or propane. **Hydronic Space Heating** (see Section 5.4.16) and **Active Solar Space Heating** (see Section 5.4.19) are covered later in this section.

Heating System Efficiency H2

The heating system for the standard design depends on the type of system specified for the proposed design. The difference between the proposed design system and the standard design system is an important factor in compliance. Table 5-4 shows the mapping between the proposed design system and the standard design system. For instance, if the proposed design system is a central gas furnace, then the standard design system is also a central gas furnace with an Annual Fuel Utilization Efficiency (AFUE) of 78%, which is equal to the prescriptive requirement. The standard design system also has sealed R-4.2 ducts (6% leakage) located in the attic. An electric resistance baseboard heating system, on the other hand, is compared to a split system heat pump with sealed air distribution ducts located in the attic and insulated with R-4.2 insulation. Non-ducted, non-central gas heaters are compared to non-ducted systems of the same type, but with an AFUE meeting minimum efficiencies. All standard design systems have setback thermostats and no zonal control.

Table 5-4 – Heating System Standard Design Map

Proposed Design System	***Standard Design System***
Gas or other fossil fuel furnace with air distribution ducts Hydronic systems of any type of distribution, including radiant panels, baseboards or fan coils Wood heating system (Note 1)	Gas furnace 78% AFUE R-4.2 sealed ducts located in attic (Note 2)
Gas wall furnaces, floor furnaces, room heaters Other non-ducted, non-central gas fired heating systems Other gas heating appliances	Gas furnace AFUE depends on unit size and type (See Table G-1) No air distribution ducts
Split system central heat pump with air distribution ducts Split system central heat pump with no air distribution ducts Electric baseboard heating system (Note 3)	Split system heat pump HSPF = 6.8 R-4.2 sealed ducts located in attic (Note 2)
Room electric heat pump	Packaged heat pump HSPF = 6.6 No air distribution ducts
Packaged heat pump with air distribution ducts	Packaged heat pump HSPF = 6.6 R-4.2 sealed ducts located in attic (Note 2)

Notes

1. The proposed design for houses with wood heating systems is modeled the same as the standard design so there is no credit or penalty related to wood heat. If the software does not have a choice for wood heat, then the compliance author must specify a gas furnace with an AFUE of 78% and sealed R-4.2 ducts in the attic.
2. Sealed ducts means that they are diagnostically tested to have a leakage less than or equal to 6% of fan flow.
3. For electric baseboard heating, an HSPF of 3.41 or ACOP of 1.00 is input; for electric radiant panels, an HSPF of 3.55 or ACOP of 1.04 is entered.
4. For central air-conditioning heat pumps that are rated with a COP, assume the actual duct conditions and calculate the HSPF as 3.2 x COP - 2.4.

If the proposed design heating system does not have ducts, then there is no need to diagnostically test the ducts.

When no equipment has been specified at the time of the compliance run, minimum efficiencies are recommended to ensure that any equipment of minimum or higher efficiency may later be installed.

For equipment that is not certified, such as radiant heaters, the efficiency value modeled must be based on either manufacturers data or an approved calculation method.

If a house has multiple HVAC systems, but does not meet zonal control criteria, for compliance purposes, model one zone using a weighted average efficiency (based on floor area served by each system).

It is not always necessary to model supplemental heat. For example, if a bathroom has a supply duct from the main space conditioning system (typically gas-fired), you can ignore the electric space heating. If the room, however, does not have a supply vent from the main system, the supplemental electric resistance is the heat source for the space. In this latter case you must model two systems--the main system for the house and the electric system for the bathroom.

Cooling System Type H3

The cooling system for the standard design depends on the type of system specified for the proposed design. The difference between the proposed design system and the standard design system is an important factor in compliance. Table 5-5 shows the mapping between the proposed design cooling system and the standard design cooling system.

Table 5-5 – Cooling System Standard Design Map

Proposed Design System	***Standard Design System***
Split system central air conditioner with or without air distribution ducts Split system central heat pump with or without air distribution ducts No cooling system (Note 1) Water or air cooled chillers with fan coils or air handler	Split system air conditioner 10 SEER Diagnostic testing of refrigerant charge and airflow (Note 3) R-4.2 sealed ducts located in attic (Note 2)
Packaged central air conditioner with or without air distribution ducts Packaged central heat pump with or without air distribution ducts	Packaged air conditioner 9.7 SEER R-4.2 sealed ducts located in attic (Note 2)
Room heat pump (non-ducted, non-central heat pump) Room air conditioner (non-ducted, non-central air conditioners)	Non-ducted, non-central air conditioner of the same type. EER depends on unit type and size (see Table G-3) No air distribution ducts

Notes:

1. If no mechanical cooling is installed or the mechanical cooling is optional, a 10.0 SEER split system air conditioner is modeled for both the proposed and standard design with R-4.2 sealed ducts (6% leakage) located in the attic. The “non-cooling” system in the proposed design is assumed to have either a verified TXV or diagnostically tested refrigerant charge and airflow.
2. Sealed ducts means that they are diagnostically tested to have a leakage less than or equal to 6% of fan flow.
3. The requirement for diagnostic testing of refrigerant charge and airflow (or verification of a TXV) applies to climates 2, and 8 through 15 only.

If the proposed design cooling system does not have ducts, then there is no need for a HERS rater to diagnostically test the ducts.

For “non-cooling” systems, there is no need for a HERS rater to diagnostically test the refrigerant charge and airflow of the hypothetical air conditioner.

If air distribution ducts are installed for a heating only system in a house with no air conditioning and the ducts are not sealed, the proposed design cooling system modeled for compliance also must have non-sealed ducts. Thus, not sealing the ducts for a heating only system creates a compliance penalty not only for both heating but for cooling as well.

Cooling System Efficiency H4

Enter the Seasonal Energy Efficiency Ratio (SEER) for either air conditioners or heat pumps. For equipment not tested for SEER (e.g., greater than 65,000 Btu capacity), use the EER in place of SEER. Non-central cooling equipment have EER requirements as specified in the Glossary under EER.

5.4.9 Ducts

The Commission has approved algorithms and procedures for determining duct efficiency. These procedures are described in Chapter 4 and in Appendix J. When the proposed design has air distribution ducts (see Table 5-4 and Table 5-5), the ducts in the standard design are assumed to be sealed per the Package D prescriptive requirements, e.g. they are required to be diagnostically tested by a HERS rater as having a leakage less than or equal to 6% of the fan flow.

Ducts embedded in a concrete slab or in the ground beneath conditioned space are modeled as R-4.2 ducts in an attic. However, it is important to use insulation materials that are resistant to moisture and suitable for below grade application.

5.4.10 Water Heating

All computer inputs for water heating correspond to the variables explained in Chapter 6.

5.4.11 Unconditioned Space

The ability to model an unconditioned space in the building is an optional modeling capability of approved computer methods. Consult the compliance supplement for specific details on the types of unconditioned spaces and their modeling procedures.

Unconditioned Zone Characteristics K1

A computer method may have a variety of capabilities that can model one or more unconditioned spaces or "zones" adjacent to conditioned space. Enclosed, unheated areas such as sunspaces, unheated storage areas and crawl spaces may be modeled explicitly if the program is approved to accurately account for the thermal interactions between conditioned and unconditioned zones. Garages and conventional attic spaces may not be modeled as unconditioned zones.

Except for crawl space modeling explained under Section 5.4.12, **Controlled Ventilation Crawl Space**, the following general descriptions cover other types of unconditioned spaces that can be modeled for compliance as part of the proposed design. The number of unconditioned spaces that can be modeled is limited only by the capabilities of the approved computer method.

Exterior Walls, Doors, Roofs/Ceilings, and Floors K2

Surfaces that separate unconditioned space from the ambient (outdoor) temperature are considered "exterior." Surfaces that separate unheated space from heated space are treated differently as part of the Coupling to Conditioned Space (see K8).

The name, area, U-factor, orientation, tilt, absorptivity and slab characteristics of each opaque surface are input in essentially the same manner as for conditioned zones. See Section 5.4.2, **Walls, Doors, Roofs/Ceilings and Floors** for further information.

Fenestration K3

Fenestration attributes are the same as those relating to conditioned zones described in Section 5.4.3, **Fenestration**.

Shading K4

Shading characteristics are the same as those defined in Section 5.4.4, **Shading**.

Thermal Mass K5

Thermal mass inputs are generally the same as those described in Section 5.4.5, **Thermal Mass**. One exception is the amount of solar gain targeted to the mass surfaces. This "Absorbed Insolation Fraction" or "Solar Gain Distribution Factor" is automatically fixed at zero for conditioned space but is a restricted variable within an unconditioned space. See the program compliance supplement for further instructions.

Infiltration and Ventilation K6

The same rules apply as explained in Section 5.4.6, **Infiltration/Ventilation**.

Thermostat Setpoints K7

Thermostat setpoints are fixed by the program to ensure that no heating or cooling will occur.

Coupling to Conditioned Space K8

The thermal connection between conditioned and unconditioned spaces is divided into conductive and convective components. The conductive heat flow is a function of the U-factor and area of the surfaces that separate the zones. The convective coupling is defined according to the actual inlet and outlet area characteristics that define ventilation between the zones.

If mechanical ventilation is to be installed, the electrical energy use of the fan must be accounted for as defined in the computer method compliance supplement.

Figure 5-3 – Controlled Ventilation Crawl Space

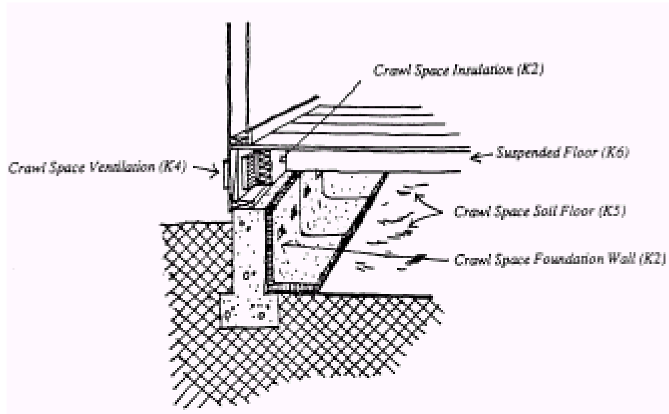


Table 5-6 – Crawl Space Soil Slab Heat Loss Rate (F2) Factor

	R-Value of Insulation						
Insulation Length Along Crawl Space Soil Floor (inches)	R-0	R-5	R-11	R-13	R-15	R-19	R-21
0	0.42	0.42	0.42	0.42	0.42	0.42	0.42
20	0.42	0.33	0.30	0.29	0.28	0.27	0.27
68	0.42	0.29	0.24	0.23	0.22	0.20	0.20

1. Based on ASHRAE Method of Calculating Transmission Heat Loss, 1989 ASHRAE Handbook of Fundamentals

5.4.12 Controlled Ventilation Crawl Space (CVC)

Crawl Space Model L1

A crawl space may be modeled as a separate unconditioned zone only when reduced crawl space vent areas are implemented. This approach is part of a Commission-approved exceptional method that establishes the crawl space soil as a type of slab with heat loss factors similar to the slab edge loss (F2) factors explained in input B11. Refer to Chapter 8, Section 8.6 for details on the requirements pertaining to installation of foundation wall insulation, drainage, ground water and soils, ventilation and crawl space ground cover.

Computer programs approved for modeling the crawl space automatically fix certain variables such as crawl space heat capacity (1.4 x suspended floor area), infiltration rate (0.22 air changes per hour), soil conductivity (0.60 Btu/hr-ft^2-ºF) and volumetric heat capacity (27 Btu/ft^3-ºF).

Crawl Space Foundation Wall L2

The foundation wall and insulation are modeled as it will be built including band joist area and the stem wall above and below outside grade level. The stem wall below the outside grade and above the crawl space grade may be considered a bermed wall and assumed to be fully shaded.

Crawl Space Volume L3

The average crawl space height from the ground to the bottom of the subfloor times the floor area above the crawl space, in cubic feet.

Crawl Space Ventilation L4

One half the actual total vent area shall be considered inlet area and one half outlet area. The crawl space ventilation area and type shall be shown on the plans and specifications.

Crawl Space Soil Floor L5

The crawl space soil floor is modeled as a four-inch thick mass element with its actual area. Slab edge losses are modeled according to the crawl space perimeter length and the slab heat loss rate (F2) factor from Table 5-6.

Suspended Floor L6

The suspended (raised) floor between the crawl space and conditioned space is modeled as built: actual area and U-factor (with indoor air films assumed for both sides of the surface).

5.4.13 Zonal Control

Zonal Control Features M1

Zonally controlled space heating and cooling systems must meet the eligibility requirements explained in Section 8.7. These systems must have a separate thermostat in the "living zone" and "sleeping zone" of the dwelling unit and a nonclosable opening area between the zones of 40 square feet or less.

A dwelling unit may meet zonal control eligibility requirements by having one or more individual HVAC units serving only the "Living" zone and one or more units serving only the "Sleeping" zone as an alternative to a single central HVAC unit with zonal control capabilities.

Approved computer programs model a zonally controlled system using certain built-in assumptions (see Figure 5-4):

- User-defined Living and Sleeping Zones, each with its own thermostat setpoints for heating, cooling and venting according to fixed occupancy schedules. These schedules include setback and setup temperatures for each zone throughout the day. (Each Living or Sleeping Zone created for modeling purposes may be comprised of one or more actual HVAC zones.)
- A U-factor of 0.293 is used for uninsulated wood frame walls between zones.
- A U-factor of 20.0 is used for nonclosable openings.
- Lightweight mass heat capacity proportioned according to each zone's percent of the total floor area.
- Internal gain distribution is 20,000 Btu + 15 Btu/ft^2 per day for the Living Zone and 15 Btu/ft^2 per day for the Sleeping Zone according to a fixed hourly schedule.

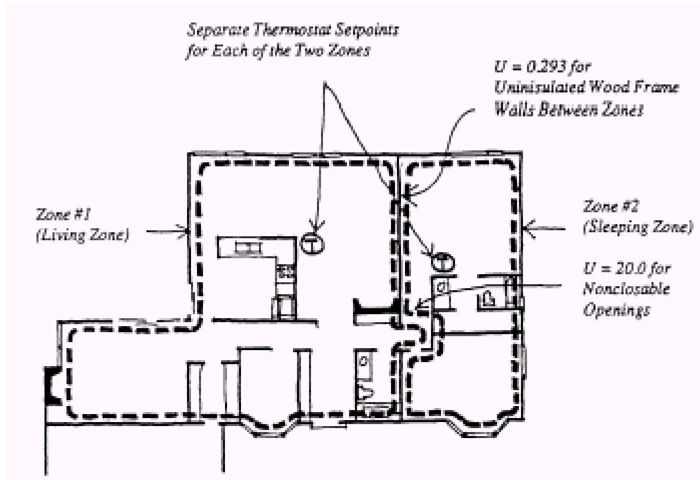
When cooling is not installed but is considered "optional", zonal credit for both heating and cooling systems can be taken as long as:

- All the zonal control criteria are met;
- The system is prepared for the cooling system (i.e., designed to be interconnected with the central furnace and with ducts sized for the air flow required for cooling);
- Common ducts are sized to handle the cooling air flow (cubic feet per minute);
- The location of the outdoor compressor is identified; and,
- The electrical panel is prepared to handle the load for a future air conditioner.

Variable Inputs M2

All physical attributes of the building are entered as part of either the Living Zone or Sleeping Zone according to the proposed building design. Fenestration and shading, walls, roofs/ceilings, floors, thermal mass and ventilation are all entered for each conditioned zone. The actual nonclosable area between zones is modeled, as well as the areas and U-factors of surfaces between zones.

Figure 5-4 – Zonal Control Modeling Assumptions



5.4.14 Radiant Barrier

Energy credit for radiant barrier installations is calculated with a modified ceiling U-factor and reduced attic temperatures that result in better HVAC distribution efficiencies for ducts in an attic below a radiant barrier.

Radiant barriers must meet specific eligibility and installation criteria as specified in Section 3.4. The radiant barrier and installation criteria will be listed on the CF-1R and C-2R as a Special Features and Modeling Assumptions.

Radiant Barriers N1

Installation of radiant barriers can improve building energy efficiency, particularly in hot climate zones. Radiant barriers are defined as fabric-type materials installed in the ceiling/roof assembly and having an emittance of 0.05 or less. To use the Commission-approved method of calculating the energy savings of radiant barriers, all installation and eligibility criteria listed in Section 3.4 must be met.

The radiant barrier energy credit is an adjustment to the ceiling U-factor allowed when the ceiling is adjacent to an attic with a radiant barrier. Consult the User's Manual for each approved computer method to determine required inputs for radiant barriers.

A radiant barrier credit is also available to account for the effects of radiant barriers on duct efficiency. This is described in Chapter 4 under duct efficiency.

5.4.15 Solar and Wood Stove Boiler Water Heating

All Inputs O1

All inputs for energy credit for use of solar or wood stove boiler-assisted water heating correspond to the variables explained in Chapter 6. Solar credit is provided through a Solar Fraction described in Chapter 6.

5.4.16 Combined Hydronic Space/Water Heating

All inputs for combined hydronic space and water heating correspond to the variables explained in Chapter 6.

5.4.17 Dedicated Hydronic Space Heating

Hydronic System Q1

A hydronic heating system is defined as one that has its space heating device(s), storage tank(s), distribution system and other components interconnected by common hot water piping. The Commission-approved method for calculating the overall efficiency of a hydronic space heating system is explained in Section 8.8. See Section 6.5 for information on combined hydronic space and water heating systems and how to calculate the energy use.

The Effective AFUE (minimum 0.80 AFUE) is obtained through that calculation method and input into the programs as the heating system efficiency with a Duct Efficiency Factor of 1.00 (ducts are assumed to be located in conditioned space). If pipes are located in unconditioned space the AFUE must be adjusted for pipe losses.

Solar water heating integrated into a combined hydronic system is explained in Section 6.3. Active Solar Space Heating is discussed in Section 5.4.19.

5.4.18 Building Additions

Various Inputs, Addition Alone R1

Internal gains are based on the fractional dwelling unit. The dwelling unit entry is determined by calculating:

$$\frac{\text{Addition}}{\text{Existing+Addition}}$$

Credit for zonal control is not allowed for an addition modeled alone.

Existing Plus Addition R2

All inputs are explained in Section 7.3.

5.4.19 Active Solar Space Heating

Active Solar Space Heating System S1

To determine the energy savings of an active solar space heating system, it is first necessary to obtain the total space heating load per month in order to enter those values into an approved version of the f-Chart program. Therefore, the monthly space heating load must be analyzed using an approved computer method so that the solar space contribution can be assessed.

Except for monthly space heating loads, all other values that are entered into f-Chart must be consistent with the fixed values listed in Section 6.3 and the actual active solar hot water system design.

Since building or dwelling unit monthly heating loads are not required as part of the standardized compliance reports (see Section 5.5), a special output report from the computer method may be needed. Consult the program compliance supplement for details.

5.5 Computer Method Documentation

5.5.1 Standard Reports

For consistency and ease of enforcement, the manner in which building features are reported by compliance computer programs is standardized. Commission approved computer programs must automatically produce compliance reports in this standard format. These standard reports are:

- Certificate of Compliance, CF-1R
- Computer Method Summary, C-2R

Both the CF-1R and the C-2R must have two highly visible sections, one for special features and modeling assumptions, and a second for features requiring verification by approved home energy rating system (HERS) raters. These two sections serve as "punchlists" for special consideration during compliance verification by the local building department and HERS rater. Items listed in the Special Features and Modeling Assumptions section indicate the compliance use of unusual features or assumptions, and that call for special care by the local building department. Items listed in the HERS Required Verification section are for features that rely on diagnostic testing and independent verification by approved HERS providers/raters to insure proper field installation. Diagnostic testing and verification by HERS providers/raters is in addition to local building department inspections.

Figure 5-5 illustrates the CF-1R and C-2R forms for sample buildings generated by an approved computer program.

5.5.2 Other Forms

Some additional forms that are required but may not be printed by the computer methods include:

- Mandatory Measures Checklist, MF-1R
- Installation Certificate, CF-6R
- Insulation Certificate, IC-1

Other forms and supporting documents may be applicable to a particular set of calculations:

- Construction Assembly U-factor, Form 3R
- Certificate of Field Verification and Diagnostic Testing, Form CF-4R

Figure 5-5 – Sample CF-1R and CF2-R Forms

```
CERTIFICATE OF COMPLIANCE: RESIDENTIAL                      Page 1         CF-1R
================================================================================
Project Title.......... 1761sf 2001 Base                  Date..05/15/01 14:48:09
Project Address........ 123 Somewhere Street     *******  ---------------------
                        Cityville                *v6.01*  | _________________ |
Documentation Author... _________________________*******  | Building Permit # |
                        Sample User                       | _________________ |
                        123 Other Street                  | Plan Check / Date |
                        Othercity, CA 90000               | _________________ |
                        800-555-1212                      | Field Check/ Date |
Climate Zone........... 12                                ---------------------
Compliance Method...... XYZ Software
================================================================================
|      XYZ Software  File-SAMPLE  Wth-CTZ12S92  Program-FORM CF-1R          |
|                User#-Sample  User-Sample User     Run-Sample                  |
--------------------------------------------------------------------------------

                              GENERAL INFORMATION
                              -------------------
           Conditioned Floor Area.....  1761 sf
           Building Type.............  Single Family Detached
           Construction Type .........  New
           Building Front Orientation.  Front Facing 90 deg (E)
           Number of Dwelling Units...  1
           Number of Stories..........  2
           Floor Construction Type....  Slab On Grade
           Glazing Percentage.........  16 % of floor area
           Average Glazing U-factor....  0.4 Btu/hr-sf-F
           Average Glazing SHGC.......  0.35
           Average Ceiling Height.....  8.9 ft

                           BUILDING SHELL INSULATION
                           -------------------------
Component     Frame  Cavity  Sheathing  Total  Assembly
  Type        Type   R-value  R-value  R-value U-factor Location/Comments
------------ ------- -------- -------- ------- ------- ------------------------
Wall          n/a     R-19     R-n/a    R-19     0.065 Right Wall
                                                       Front Wall, Left Wall
                                                       Back Wall
RoofRadiant   n/a     R-38     R-n/a    R-38     0.028 Attic Ceiling
Door          n/a     R-0      R-n/a    R-0      0.330 North Door
Floor         n/a     R-19     R-n/a    R-19     0.037 Garage Floor
SlabEdge      n/a     R-0      R-n/a          F2=0.760 Exposed Edge

                                  FENESTRATION
                                  ------------
                                                         Over-
                      Area    U-          Exterior       hang/
 Orientation          (sf)   Value  SHGC  Shading        Fins    Location/Comment
 -------------------- ----- ------ ------  -------------- ----- ----------------
 Window   Right (N)    70.4  0.400  0.350 Standard        None
 Window   Front (E)    70.4  0.400  0.350 Standard        None
 Window   Left  (S)    70.4  0.400  0.350 Standard        None
 Window   Back  (W)    70.4  0.400  0.350 Standard        None
```

Figure 5-5 – Sample CF-1R and CF2-R Forms (continued)

```
CERTIFICATE OF COMPLIANCE: RESIDENTIAL                   Page 2         CF-1R
===============================================================================
Project Title.......... 1761sf 2001 Base              Date..05/15/01 14:48:09
===============================================================================
|      XYZ Software  File-SAMPLE  Wth-CTZ12S92  Program-FORM CF-1R        |
|                User#-Sample  User-Sample User     Run-Sample                |
-------------------------------------------------------------------------------

                                SLAB SURFACES
                                -------------
                                            Area
                            Slab Type        (sf)
                            ---------------- ------
                               Standard Slab   925

                                 HVAC SYSTEMS
                                 ------------
                         Refrigerant                 Tested   ACCA
 Equipment     Minimum   Charge and   Duct     Duct   Duct   Manual Thermostat
   Type       Efficiency  Airflow   Location  R-value Leakage   D       Type
------------ ------------ ------- ----------- ------- ------- ------ ----------
Furnace       0.780 AFUE    n/a   Attic        R-4.2  Yes       No    Setback
ACSPLITTXV    10.00 SEER    Yes   Attic        R-4.2  Yes       No    Setback

                              DUCT TESTING DETAILS
                              --------------------
                                   Duct         Measured Supply
                                Leakage Target    Duct Surface Area
      Equipment Type           (% fan CFM/CFM25)        (ft2)
      ------------------------ ------------------ -----------------
       Furnace / ACSPLITTXV           6% /   74.0       n/a

                             WATER HEATING SYSTEMS
                             ---------------------
                                            Number          Tank   External
                                              in    Energy  Size   Insulation
 Tank Type    Heater Type  Distribution Type  System  Factor  (gal)  R-value
 ------------ ----------- ------------------- ------ -------- ------ ----------
 Storage      Gas         Standard               1     0.60     50     R- n/a

                  SPECIAL FEATURES AND MODELING ASSUMPTIONS
                  -----------------------------------------
       *** Items in this section should be documented on the plans, ***
       *** installed to manufacturer and CEC specifications, and     ***
       *** verified during plan check and field inspection.          ***

This building incorporates a Radiant Barrier. The radiant barrier must be
installed to cover all gable end walls and other vertical surfaces in the attic
and attic ventilation criteria must be met.

This building incorporates Tested Duct Leakage.

Leaks in the air distribution system connections shall not be sealed
with cloth backed rubber adhesive duct tapes unless such tape is used
in combination with mastic and drawbands.
```

Figure 5-5 – Sample CF-1R and CF2-R Forms (continued)

```
CERTIFICATE OF COMPLIANCE: RESIDENTIAL                    Page 3          CF-1R
===============================================================================
Project Title.......... 1761sf 2001 Base                Date..05/15/01 14:48:09
===============================================================================
|      XYZ Software  File-SAMPLE  Wth-CTZ12S92  Program-FORM CF-1R         |
|                User#-Sample  User-Sample User     Run-Sample                |
-------------------------------------------------------------------------------

                   SPECIAL FEATURES AND MODELING ASSUMPTIONS
                   -----------------------------------------

This building incorporates either Tested Refrigerant Charge and Airflow (RCA)
or a Thermostatic Expansion Valve (TXV) on the specified air conditioning
system(s).

                          HERS REQUIRED VERIFICATION
                          --------------------------
         *** Items in this section require field testing and/or    ***
         *** verification by a certified home energy rater under   ***
         *** the supervision of a CEC-approved HERS provider using ***
         *** CEC approved testing and/or verification methods.     ***

This building incorporates Tested Duct Leakage. Target CFM leakage
values measured at 25 pascals are shown in DUCT TESTING DETAILS above
or may be calculated as documented on the CF-6R. If the measured CFM
is above the target, then corrective action must be taken to reduce
the duct leakage and then must be retested. Alternatively, the
compliance calculations could be redone without duct testing.

Because a non-default duct configuration is specified,
leaks in the air distribution system connections shall not be sealed
with cloth backed rubber adhesive duct tapes unless such tape is used
in combination with mastic and drawbands.

This building incorporates either Tested Refrigerant Charge and Airflow (RCA)
or a Thermostatic Expansion Valve (TXV) on the specified air conditioning
system(s).
                                    REMARKS
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________
```

Figure 5-5 – Sample CF-1R and CF2-R Forms (continued)

```
CERTIFICATE OF COMPLIANCE: RESIDENTIAL                    Page 4         CF-1R
===============================================================================
Project Title.......... 1761sf 2001 Base                Date..05/15/01 14:48:09
===============================================================================
|      XYZ Software  File-SAMPLE  Wth-CTZ12S92  Program-FORM CF-1R        |
|                User#-Sample  User-Sample User     Run-Sample               |
-------------------------------------------------------------------------------

                              COMPLIANCE STATEMENT
                              --------------------
  This certificate of compliance lists the building features and performance
  specifications  needed  to  comply with Title-24, Parts 1  and  6  of  the
  California  Code  of Regulations, and the  administrative  regulations  to
  implement them.  This certificate has been signed by the  individual  with
  overall  design  responsibility.  When this certificate of  compliance  is
  submitted for a single building plan to be built in multiple orientations,
  any  shading feature that is varied is indicated in  the  Special Features
  Modeling Assumptions section.

           DESIGNER or OWNER                   DOCUMENTATION AUTHOR

  Name.... Bill Designer            Name.... ________________________________
  Company. Builder                  Company. Sample User
  Address. 123 Other Street         Address. 123 Other Street
           Othercity, CA 90000                Othercity, CA 90000
  Phone... 800-555-1212             Phone... 800-555-1212
  License. _________________________

  Signed.. _________________________  Signed.. _________________________
                             (date)                              (date)

           ENFORCEMENT AGENCY

  Name.... _________________________
  Title... _________________________
  Agency.. _________________________
           _________________________
  Phone... _________________________

  Signed.. _________________________
                             (date)
```

Figure 5-5 – Sample CF-1R and CF2-R Forms (continued)

```
COMPUTER METHOD SUMMARY                                    Page 1          C-2R
================================================================================
Project Title.......... 1761sf 2001 Base                 Date..05/15/01 14:48:09
Project Address........ 123 Somewhere Street     *******  ---------------------
                        Cityville                *v6.01*  | _________________ |
Documentation Author... _________________________*******  | Building Permit # |
                        Sample User                       | _________________ |
                        123 Other Street                  | Plan Check / Date |
                        Othercity, CA 90000               | _________________ |
                        800-555-1212                      | Field Check/ Date |
Climate Zone........... 12                                ---------------------
Compliance Method...... XYZ Software
================================================================================
|      XYZ Software  File-SAMPLE  Wth-CTZ12S92  Program-FORM C-2R          |
|               User#-Sample  User-Sample User     Run-Sample                  |
--------------------------------------------------------------------------------


       =================================================================
       =                 Generic XYZ ENERGY USE SUMMARY                  =
       =                 ----------------------------                  =
       =  Energy Use             Standard    Proposed   Compliance  =
       =  (kBtu/sf-yr)            Design      Design      Margin    =
       =  -----------------------  ----------  ----------  ----------  =
       =  Space Heating..........     17.50       14.95        2.55    =
       =  Space Cooling..........      6.59        5.58        1.01    =
       =  Water Heating..........     14.15       12.31        1.84    =
       =                           --------    --------    --------   =
       =                  Total     38.24       32.84        5.40    =
       =                                                               =
       =     *** Building complies with Computer Performance ***      =
       =================================================================

                             GENERAL INFORMATION
                             -------------------
             Conditioned Floor Area.....  1761 sf
             Building Type.............  Single Family Detached
             Construction Type .........  New
             Building Front Orientation.  Front Facing 90 deg (E)
             Number of Dwelling Units...  1
             Number of Building Stories.  2
             Weather Data Type.........  Fullyear

             Floor Construction Type....  Slab On Grade
             Number of Building Zones...  1
             Conditioned Volume.........  15588 cf
             Slab-On-Grade Area.........  925 sf
             Glazing Percentage.........  16 % of floor area
             Average Glazing U-factor....  0.4 Btu/hr-sf-F
             Average Glazing SHGC.......  0.35
             Average Ceiling Height.....  8.9 ft
```

Figure 5-5 – Sample CF-1R and CF2-R Forms (continued)

```
COMPUTER METHOD SUMMARY                                            Page 2          C-2R
===============================================================================
Project Title.......... 1761sf 2001 Base                        Date..05/15/01 14:48:09
===============================================================================
|      XYZ Software  File-SAMPLE  Wth-CTZ12S92  Program-FORM C-2R          |
|                User#-Sample  User-Sample User     Run-Sample                |
-------------------------------------------------------------------------------

                           BUILDING ZONE INFORMATION
                           -------------------------
               Floor         # of                          Vent   Vent      Air
               Area  Volume  Dwell  Cond-  Thermostat  Height  Area    Leakage
Zone Type      (sf)   (cf)   Units itioned    Type       (ft)   (sf)    Credit
-------------- ----- ------- ----- ------- ----------- ----- -------- ---------
HOUSE
 Residence      1761  15588   1.00   Yes   Setback       8.0 Standard   No

                                OPAQUE SURFACES
                                ---------------
                Area   U-   Insul Act      Solar    Form 3       Location/
Surface         (sf)  value R-val Azm Tilt Gains  Reference      Comments
-------------- ------ ----- ----- --- ---- ----- ------------ ----------------
HOUSE
 1 Wall           358  0.065 19      0    90 Yes  None         Right Wall
 2 Wall           398  0.065 19     90    90 Yes  None         Front Wall
 3 Wall           398  0.065 19    180    90 Yes  None         Left Wall
 4 Wall           398  0.065 19    270    90 Yes  None         Back Wall
 5 RoofRadiant  1261  0.028 38    n/a     0 Yes  None         Attic Ceiling
 6 Door            40  0.330 0       0    90 Yes  None         North Door
 7 Floor          286  0.037 19    n/a     0 No   None         Garage Floor

                                PERIMETER LOSSES
                                ----------------
                   Length    F2      Insul  Solar
      Surface       (ft)   Factor   R-val  Gains Location/Comments
      ------------ ------ -------- ------- ----- ---------------------
      HOUSE
       8 SlabEdge    124    0.760  R-0       No  Exposed Edge

                             FENESTRATION SURFACES
                             ---------------------
                        Area   U-        Act      Exterior Shade
Orientation             (sf) Value SHGC  Azm Tilt Type/SHGC      Location/Comment
---------------------- ----- ----- ----- --- ---- -------------- --------------
HOUSE
 1 Window   Right (N)   70.4 0.400 0.350   0   90  Standard/0.76
 2 Window   Front (E)   70.4 0.400 0.350  90   90  Standard/0.76
 3 Window   Left  (S)   70.4 0.400 0.350 180   90  Standard/0.76
 4 Window   Back  (W)   70.4 0.400 0.350 270   90  Standard/0.76
```

Figure 5-5 – Sample CF-1R and CF2-R Forms (continued)

```
COMPUTER METHOD SUMMARY                                      Page 3          C-2R
===============================================================================
Project Title.......... 1761sf 2001 Base                Date..05/15/01 14:48:09
===============================================================================
|      XYZ Software  File-SAMPLE  Wth-CTZ12S92  Program-FORM C-2R          |
|                User#-Sample  User-Sample User     Run-Sample                |
-------------------------------------------------------------------------------

                                SLAB SURFACES
                                -------------
                                             Area
                             Slab Type       (sf)
                             ---------------- ------
                             HOUSE
                                Standard Slab   925

                                 HVAC SYSTEMS
                                 ------------
                         Refrigerant                     Tested     ACCA
  System       Minimum   Charge and   Duct       Duct     Duct     Manual  Duct
   Type       Efficiency  Airflow   Location    R-value  Leakage     D     Eff
------------- ----------- ------- ------------- ------- --------- -------- ----
HOUSE
 Furnace       0.780 AFUE   n/a    Attic          R-4.2    Yes      No    0.848
 ACSPLITTXV    10.00 SEER   Yes    Attic          R-4.2    Yes      No    0.796

                              DUCT TESTING DETAILS
                              --------------------
                                   Duct         Measured Supply
                              Leakage Target    Duct Surface Area
      Equipment Type         (% fan CFM/CFM25)        (ft2)
      ------------------------ ------------------ -----------------
      HOUSE
       Furnace / ACSPLITTXV           6% /   74.0       n/a

                             WATER HEATING SYSTEMS
                             ---------------------
                                              Number          Tank   External
                                                in    Energy  Size   Insulation
 Tank Type    Heater Type  Distribution Type  System  Factor  (gal)  R-value
 ------------ ----------- ------------------- ------ -------- ------ ----------
  1 Storage   Gas         Standard               1     0.60     50     R- n/a

                   SPECIAL FEATURES AND MODELING ASSUMPTIONS
                   -----------------------------------------
       *** Items in this section should be documented on the plans, ***
       *** installed to manufacturer and CEC specifications, and    ***
       *** verified during plan check and field inspection.         ***

This building incorporates a Radiant Barrier. The radiant barrier must be
installed to cover all gable end walls and other vertical surfaces in the attic
and attic ventilation criteria must be met.

This building incorporates Tested Duct Leakage.

Because a non-default duct configuration is specified,
leaks in the air distribution system connections shall not be sealed
with cloth backed rubber adhesive duct tapes unless such tape is used
```

Figure 5-5 – Sample CF-1R and CF2-R Forms (continued)

```
COMPUTER METHOD SUMMARY                                   Page 4          C-2R
==============================================================================
Project Title.......... 1761sf 2001 Base              Date..05/15/01 14:48:09
==============================================================================
|      XYZ Software  File-SAMPLE  Wth-CTZ12S92  Program-FORM C-2R         |
|                User#-Sample  User-Sample User     Run-Sample               |
------------------------------------------------------------------------------

                   SPECIAL FEATURES AND MODELING ASSUMPTIONS
                   -----------------------------------------
in combination with mastic and drawbands.

This building incorporates either Tested Refrigerant Charge and Airflow (RCA)
or a Thermostatic Expansion Valve (TXV) on the specified air conditioning
system(s).

                          HERS REQUIRED VERIFICATION
                          --------------------------
         *** Items in this section require field testing and/or    ***
         *** verification by a certified home energy rater under    ***
         *** the supervision of a CEC-approved HERS provider using ***
         *** CEC approved testing and/or verification methods.      ***

This building incorporates Tested Duct Leakage. Target CFM leakage
values measured at 25 pascals are shown in DUCT TESTING DETAILS above
or may be calculated as documented on the CF-6R. If the measured CFM
is above the target, then corrective action must be taken to reduce
the duct leakage and then must be retested. Alternatively, the
compliance calculations could be redone without duct testing.

Because a non-default duct configuration is specified,
leaks in the air distribution system connections shall not be sealed
with cloth backed rubber adhesive duct tapes unless such tape is used
in combination with mastic and drawbands.

This building incorporates either Tested Refrigerant Charge and Airflow (RCA)
or a Thermostatic Expansion Valve (TXV) on the specified air conditioning
system(s).
                                    REMARKS
______________________________________________________________________________
______________________________________________________________________________
```

5.6 Standard Design Assumptions

Each approved computer method must automatically calculate the energy budget for the standard design (see Section 5.2). This feature of the computer method must define the custom budget or Standard Design run based upon data entered for the Proposed Design using all the correct fixed and restricted inputs. These inputs cannot be altered in the Proposed Design except as specified in Section 5.4 or the computer method compliance supplement.

The computer method defines the standard design by modifying the geometry of the Proposed Design and inserting the building features of Package D as specified in the *Standards*. This process is built into each approved computer method (ACM) and the user cannot access it. Key details on how the standard design is created and calculated by the computer methods, including the listing of fixed and restricted input assumptions, is available in the latest edition of the Commission's **Residential Alternative Calculation Methods Approval Manual,** Standard Design: General Approach.

The basis of the standard design is Package D, contained in Table 3-1.

The standard design assumes the same total conditioned floor area, conditioned slab floor area, and volume as the proposed design, and the same gross exterior wall area as the proposed design, except that the wall area in each of the four cardinal orientations is equal. The standard design uses the same roof/ceiling area, raised floor area, slab-on-grade area and perimeter as the proposed design, assuming the standard insulation R-values required in the prescriptive packages.

Total fenestration area is determined by the package specification and evenly distributed between the four cardinal orientations. Solar heat gain coefficients are those listed in Packages D, and no fixed shading devices such as overhangs are assumed.

The standard design includes minimum efficiency heating and cooling equipment, as well as the minimum duct R-value with ducts in a vented attic and tested duct leakage. Assumptions for refrigerant charge and airflow are those listed in Package D. The water heating system of the standard design is assumed to be equal to the water heating energy budget (explained in Chapter 6).